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SHERWIN-WILLIAMS
**Insulating Varnishes
and Compounds**

THE SHERWIN-WILLIAMS Co.

INSULATING MATERIALS DEPARTMENT, CLEVELAND, OHIO

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THE SHERWIN-WILLIAMS Co.

FOREWORD

INSULATING Varnish is one of the most important, if not the most important, of all the insulating materials used in the construction of electrical apparatus.

It is not only an insulator itself, but also serves to protect and preserve the insulating properties of the other insulating materials and thereby greatly increases the life of the insulation and the apparatus on which it is used.

Its importance should not be judged, as is frequently done, by the relatively small quantity required and the monetary value of the varnish. The cost is insignificant when compared with the cost of the iron, copper, steel and other raw materials, but if the varnish fails, the insulation is subjected to the many destructive agencies which soon cause it to break down, with the result that the machine on which the varnish is used becomes inoperative.

Realizing the need of varnishes which would successfully withstand the peculiarly difficult conditions to which Insulating Varnishes are subjected, The Sherwin-Williams Company has developed a line of varnishes especially suitable for this purpose. These varnishes, under our trade name "Ajax," have been in successful use for over twenty years, both in the United States and Europe, and are today the most extensively used Insulating Varnishes in the electrical industry.

All of these products are of the highest quality. Their composition has been determined by scientific study and experiment; only pure ingredients are used, and scrupulous care is exercised in every process of manufacture. Exacting laboratory tests of the finished products before shipment are a further guarantee of results satisfactory to the user.

These varnishes and compounds are described in the pages which follow. We have also endeavored to give other general information which would be helpful in the selection of the proper varnishes or compounds, and in their use.

It is not possible within the limits of this catalog to cover every possible application of Insulating Varnish. Any additional information which may be desired will be gladly furnished. We desire to not only supply Insulating Varnishes and Compounds, but to be helpful in their use, and offer you the services of our Engineering Department in the solution of your Insulating Varnish problems.

The Sherwin-Williams Co.

Fundamental Characteristics of Insulating Varnishes

Due probably to the relatively small quantity of varnishes used, as compared with other materials, and also the fact that the composition and chemistry of varnishes is a study rather outside the scope of electrical engineering, there does not exist in the electrical industry a very complete understanding of the fundamental characteristics of insulating varnishes. It is thought that a more complete understanding of these fundamental characteristics will be helpful to the user in selecting the most suitable varnishes, and in securing the most satisfactory results from their use.

The simplest form of varnish is what is commonly known as a spirit varnish. A varnish of this type consists merely of a varnish gum or resin, dissolved in a suitable solvent, usually alcohol. Shellac varnish is a familiar example of this type. When the varnish is applied the solvent evaporates and leaves a thin film of the gum. The physical and electrical characteristics of this film depend entirely on the characteristics of the gum which is used in the varnish. An oil-proof gum will produce an oil-proof varnish, and the principal use of spirit varnishes in the electrical industry is to produce an oil-proof finishing coating. The varnish may be colored any desired color, but the only kinds used to any extent are the clear and black.

The greatest weakness of spirit varnishes is their brittle nature. Being composed of nothing but a gum and solvent, they do not possess the necessary degree of elasticity and toughness to be suitable for most applications. They are also not as waterproof as the oil type varnishes.

The oil type varnish, or oleoresinous varnish, as it is technically called, consists of a varnish gum or resin in combination with a vegetable drying oil or oils, dissolved in a suitable thinner. This varnish is made in a manner entirely different from a spirit varnish. The gum and oils are first fused together at a high temperature in a varnish kettle, after which the volatile thinner is added.

This varnish dries in a manner entirely different from a spirit varnish. The volatile thinner first evaporates and leaves the film of fused gum and oil on the surface to be coated. Incidentally the only purpose of the thinner is to reduce the

viscosity of the varnish to a point where it can be applied in thin films. It forms no part of the final film whatever. At this stage, the varnish is still not dry. The vegetable drying oils in the varnish then absorb oxygen from the air, which combining chemically with the oils, cause them to solidify and harden. The absorption of oxygen and oxidation of the oils is accelerated by the action of heat—hence the general use of baking varnishes. It should be understood that the action of heat alone does not harden the varnish. It merely accelerates the evaporation of the solvent and the chemical change involved in the oxidation of the oils.

The addition of the oil to the gum in the oil type varnish produces a varnish which is much more tough, elastic, and water-resisting. For this reason varnishes of this type are used almost exclusively for insulating purposes.

For producing clear varnishes, the clear varnish gums or resins are used, and for producing black varnishes some of the various asphaltic materials are used, both of course in conjunction with suitable oils and solvents. The use of different gums imparts somewhat different physical characteristics to the varnish.

Unfortunately with the physical limitations of the raw materials available for making varnishes, it is not possible to make an ideal insulating varnish which would be suitable for every purpose. For example, a varnish to possess the maximum life under heat would have to contain the maximum quantity of oil and this in turn would lengthen the baking time to an impractical point. It would also be extremely difficult to oxidize and harden such a varnish if used in deep slots and other locations where it was not exposed to the air. As a result it has been necessary to develop a number of varnishes, each of which possesses the proper balance of those physical and electrical properties which make it suitable for a particular application.

The oil type varnishes are divided into two classes—air drying and baking, depending upon the method of drying. The air drying varnishes contain only a relatively small quantity of drying oils, and for this reason will successfully air dry. The baking varnishes contain a much greater quantity of oil, and require the action of heat to satisfactorily oxidize or harden the oil. It follows, then, that the baking varnishes are much more durable than the air drying varnishes, and the latter are generally not used, excepting where baking facilities are not available, or for certain applications where the highest grade varnish is not required.

The physical characteristics of clear varnishes differ somewhat from black varnishes—the electrical characteristics, however, are practically the same.

In the manufacture of clear varnishes, it is possible by varying the proportions of the drying oils (linseed, wood oil, etc.) and gum, and by different heat treatments, to considerably modify the physical characteristics of the varnish. In this catalog four different clear baking varnishes are described. The insulating properties of these four varnishes are practically the same—the difference being in the physical characteristics.

Clear Elastic Baking Varnish No. 16 is a very elastic, flexible varnish, possessing maximum resistance to heat. It would be especially suitable for making varnished cambric, and for use on form-wound coils where its flexibility would facilitate assembling the coils in armature or stator slots. The extreme resistance to heat would also make it the most satisfactory clear varnish for use on generators and motors exposed to overloads and heating.

Clear Quick Elastic Baking Varnish No. 14 is a very hard, tough varnish, possessing maximum binding and cementing properties, and these characteristics would make it the most satisfactory clear varnish for use on small armatures, where the varnish is relied upon to bind and cement the wires together and hold them firmly in place.

The other two clear baking varnishes have their own particular fields of usefulness, as outlined in the pages describing these varnishes.

There is a greater number of raw materials available for making black varnishes, and the physical characteristics of black varnishes vary more than clear varnishes.

Black Elastic Baking Varnish No. 20 is a very elastic, flexible varnish, having maximum resistance to heat. It has the same physical characteristics as No. 16 Clear Varnish, and the uses are the same.

Black Quick Baking Varnish No. 23 is a very hard, tough varnish, and resembles No. 14 Clear Varnish in this respect more than any other black varnish. It is the ideal black varnish for use on small D C armatures and small and intermediate size A C stator windings.

Black Plastic Baking Varnish No. 21 is a varnish of an entirely different type from any of the varnishes previously described. It is composed largely of soft plastic materials, which do not harden and become brittle through the action

of heat. This gives it a very long life under heat. It contains only a small quantity of drying oils and for this reason bakes out better in deep coils and cavities than any other varnish. These characteristics make it a very suitable varnish for use on A C stator windings and large form-wound coils. On account of the plastic nature of the varnish it does not give satisfactory results on small high speed D C armatures.

Black Semi-Plastic Baking Varnish No. 22 is similar to but somewhat harder than the No. 21 Varnish.

Quite frequently a particular condition can be met more successfully by the use of two varnishes, than by one alone. For example, large form-wound coils can be first treated with Black Plastic Baking Varnish to thoroughly impregnate the insulation and finished with a coat of Black or Clear Elastic Baking Varnish. The Black Plastic Varnish will bake out better in the coils, and either of the Elastic Baking Varnishes will provide a tough, flexible oil-proof coating on the outside of the coils.

Another frequent combination is to use the Black Plastic or Semi-Plastic Varnish on intermediate size A C motors, dipping the windings and core in the varnish, and after baking to apply a coating of Black Air Drying Spirit Varnish over the Black Plastic Varnish. The Spirit Varnish can be applied most satisfactorily by means of an air brush. It provides a hard, glossy oil-proof coating over the softer plastic varnish.

The best practice in treating small D C and universal motors is to use a clear baking varnish on the armature and a black plastic or semi-plastic baking varnish on the field coils. A black air drying varnish may also be used for the latter purpose with satisfactory results.

Only a few of the many applications of insulating varnish have been suggested above. The reader is referred to the chart on the opposite page and to the descriptions of the various varnishes and compounds in the catalog, for further uses and applications of these materials.

It is hoped that the information contained in this catalog will be helpful to the reader in selecting the proper varnish or varnishes for each specific application and to secure thoroughly satisfactory results from their use.

Suggested Uses for Ajax Clear and Black Baking Varnishes

	CLEAR VARNISHES				BLACK VARNISHES			
Characteristics of Clear and Black Baking Insulating Varnishes and uses for which they are recommended. Order of suitability indicated by letters "A, B and C." Where same letter is shown for more than one varnish, it indicates that they are equal so far as that characteristic or use is concerned.	Clear Elastic Baking Varnish No. 16	Clear Quick Elastic Baking Varnish No. 14	Clear Quick Baking Varnish No. 17	Clear Air Drying and Baking Varnish No. 18	Black Elastic Baking Varnish No. 20	Black Quick Baking Varnish No. 23	Black Semi-Plastic Baking Varnish No. 22	Black Plastic Baking Varnish No. 21
Flexibility.....	A	B	C	D	A	B	B	A
Toughness.....	B	A	B	B	B	A	C	D
Plasticity.....	::	::	::	::	::	::	B	A
Life under heat.....	A	B	C	D	A	B	B	A
Oil Resistance.....	A	A	B	B	B	B	C	D
Varnished cambric.....	A	::	::	::	A	::	::	::
Oil cooled transformers.....	B	A	::	::	::	::	::	::
Large from-wound								
Stator coils.....	*A	*B	::	::	*A	*B	B	A
Armature coils.....	*A	*B	::	::	*A	*B	B	A
Small form-wound								
Stator coils.....	A	B	::	::	A	B	B	A
Armature coils.....	B	A	C	::	B	A	B	::
Dipping after assembling coils								
Large stators.....	A	B	::	::	A	B	B	B
Small stators.....	::	A	::	::	::	A	B	B
Large armatures.....	A	B	C	::	A	B	B	C
Small armatures.....	C	A	B	::	C	A	B	::
Hand-wound stators:								
Intermediate size.....	::	B	::	::	::	A	A	B
Small size.....	::	B	C	::	::	A	A	C
Hand-wound armatures								
Auto starter type.....	::	A	B	::	::	B	::	::
Vacuum cleaner type.....	::	B	A	C	::	B	::	::
Fan motor type.....	::	A	B	::	::	A	B	::
D C field coils:								
Large.....	::	::	::	::	::	::	B	A
Small.....	::	::	::	::	::	::	B	A
Magnetos and induction coils..	::	A	B	::	::	B	::	::

*Suggested as finishing coating over No. 21 or No. 22 Varnish.

NOTE—Specific gravities shown on the following pages are computed at a standard temperature of 20°C (68°F.)

Ajax Baking Insulating Varnish

Ajax Clear Elastic Baking Varnish No. 16.

An extremely elastic, flexible varnish which is oil, acid and waterproof. Has highest dielectric strength and maximum life under heat. Intended for use where extreme flexibility and longest life under heat are required, such as on large form-wound armature and stator coils, in making varnished cambric, etc. Other uses are suggested on page 9.

The baking time on coils, etc., when applied at the proper specific gravity, for two-coat work, is from ten to twelve hours at 100°C (212°F). On cloth about one hour at 110°C (230°F). If one heavy coat is applied the baking time should be increased.

The varnish is supplied at a specific gravity of .880. On two-coat work it should be reduced from 20 to 30% with benzine to obtain the proper thickness of coating. General directions for use are given on pages 21 to 25.

Ajax Clear Quick Elastic Baking Varnish No. 14.

A very strong, tough varnish which is oil, acid, and waterproof. Has highest dielectric strength, long life under heat and maximum binding and cementing properties. Intended for use where a strong, tough varnish is required, such as on hand-wound armatures, oil cooled transformers, form-wound armature and stator coils, etc. Other uses are suggested on page 9.

The baking time on armatures, coils, etc., when applied at the proper specific gravity, for two-coat work, is from eight to ten hours at 100°C (212°F). If one heavy coat is applied the baking time should be increased.

The varnish is supplied at a specific gravity of .873. On two-coat work it should be reduced from 20 to 30% with benzine to obtain the proper thickness of coating. General directions for use are given on pages 21 to 25.

Ajax Clear Quick Baking Varnish No. 17.

A hard, tough varnish which is oil, acid and water-proof. Has highest dielectric strength and excellent binding and cementing properties. Intended for use where a hard, tough, quick baking varnish is required. An excellent varnish for use on small hand-wound armatures, coils, etc., not subjected to the most severe conditions of usage. Other uses are suggested on page 9.

The baking time on armatures, coils, etc., when applied at the proper specific gravity, for two-coat work, is from six to eight hours at 100°C (212°F). If one heavy coat is applied the baking time should be increased.

The varnish is supplied at a specific gravity of .870. On two-coat work it should be reduced from 20 to 30% with benzine, to obtain the proper thickness of coating. General directions for use are given on pages 21 to 25.

Ajax Clear Air Drying and Baking Varnish No. 18.

A quick drying varnish which is oil, acid and water-proof. Has high dielectric strength and good binding and cementing properties. Intended for use where an extra quick baking varnish is required, or where baking facilities are not available. Suitable for small hand-wound armatures, coils, etc., not subjected to severe conditions of usage.

The baking time when applied at the proper specific gravity, for two-coat work, is from five to seven hours at 100°C (212°F). If one heavy coat is applied the baking time should be increased. It will air dry in from eight to fourteen hours.

The varnish is supplied at a specific gravity of .850. On two-coat work it should be reduced from 10 to 20% with benzine to obtain the proper thickness of coating. General directions for use are given on pages 21 to 25.

Ajax Black Elastic Baking Varnish No. 20.

An extremely elastic, flexible varnish which is oil, acid and water-proof. Has highest dielectric strength and maximum life under heat. Intended for use where extreme flexibility and longest life under heat are required, such as on large form-wound armature and stator coils, etc. Other uses are suggested on page 9.

The baking time on coils, etc., when applied at the proper specific gravity, for two-coat work, is from ten to twelve hours at 100°C (212°F). If one heavy coat is applied the baking time should be increased.

The varnish is supplied at a specific gravity of .875. On two-coat work it should be reduced from 20 to 30% with benzine, to obtain the proper thickness of coating. General directions for use are given on pages 21 to 25.

Ajax Black Plastic Baking Varnish No. 21.

A black varnish which dries with a soft plastic film. Is acid-proof and water-proof, but only fairly resistant to oils.

Has highest dielectric strength, and maximum life under heat. Intended for use on field and stator coils, assembled stators and large armatures. Not suitable for use on small high-speed hand-wound armatures. Other uses are suggested on page 9.

The baking time on coils, etc., when applied at the proper specific gravity, for two-coat work, is from ten to twelve hours at 100°C (212°F). If one heavy coat is applied the baking time should be increased.

The varnish is supplied at a specific gravity of .870. On two-coat work it should be reduced from 20 to 30% with benzine to obtain the proper thickness of coating. General directions for use are given on pages 21 to 25.

Ajax Black Semi-Plastic Baking Varnish No. 22.

A black varnish which dries with a semi-plastic film. Is acid and water-proof and has fairly good oil-resisting qualities. Has highest dielectric strength and long life under heat. Intended for use on field and stator coils, assembled stators and large and small armatures. Other uses are suggested on page 9.

The baking time on coils, etc., when applied at the proper specific gravity, for two-coat work, is from eight to ten hours at 100°C (212°F). If one heavy coat is applied the baking time should be increased.

The varnish is supplied at a specific gravity of .870. On two-coat work it should be reduced from 20 to 30% with benzine to obtain the proper thickness of coating. General directions for use are given on pages 21 to 25.

Ajax Black Quick Baking Varnish No. 23.

A very hard, tough varnish, which is oil, acid, and water-proof. Has highest dielectric strength, long life under heat, and excellent binding and cementing properties. Intended for use where a hard, tough varnish is required. Suitable for large and small armatures, field and stator coils, and assembled stators. Other uses are suggested on page 9.

The baking time on coils, etc., when applied at the proper specific gravity, for two-coat work, is from eight to ten hours at 100°C (212°F). If one heavy coat is applied the baking time should be increased.

The varnish is supplied at a specific gravity of .870. On two-coat work it should be reduced from 20 to 30% with benzine to obtain the proper thickness of coating. General directions for use are given on pages 21 to 25.

Ajax Air Drying Insulating Varnishes

Ajax Black Air Drying Varnish No. 25.

A black air drying varnish which dries with a fairly hard film. Has excellent insulating properties. Is acid-proof and water-proof, but not thoroughly oil-proof. Intended for use where baking facilities are not available. Suitable for field and stator coils, and all types of armatures, except small high-speed hand-wound armatures. Good for general repair work.

Will air dry on a flat surface in one hour. Requires from four to eight hours to dry in the interior of a coil, depending on the nature of the coil. Can be baked in one hour at 100°C (212°F).

The varnish is supplied at a specific gravity of .855. May be reduced with benzine to obtain any desired thickness of coating. General directions for use are given on page 25.

Ajax Clear Air Drying Finishing Varnish No. 19.

A clear spirit finishing varnish. Has good insulating properties. Is thoroughly oil and moisture-proof, and produces a transparent, glossy coating. Intended for use as a finishing coating on armatures, field and stator coils, etc., to prevent absorption of lubricating oils and moisture. Machines finished with this varnish may be cleaned by washing with benzine and waste. Will air dry in about twenty minutes.

The varnish is supplied at a specific gravity of .910. May be thinned with denatured alcohol to obtain any desired thickness of coating. The varnish may be applied by spraying, dipping, or brushing. General directions for use are given on page 25.

Ajax Black Air Drying Finishing Varnish No. 26.

A black spirit finishing varnish. Has good insulating properties. Is thoroughly oil and moisture proof, and produces a beautiful black glossy finish. Intended for use as a finishing coating on armatures, field and stator coils, etc., to prevent absorption of lubricating oil and moisture. Machines finished with this varnish may be cleaned by washing with benzine and waste. Will air dry in about twenty minutes.

The varnish is supplied at a specific gravity of .910. May be thinned with denatured alcohol to obtain any desired thickness of coating. The varnish may be applied by spraying, dipping, or brushing. General directions for use are given on page 25.

Black Acid-Proof Paints

Underwriters' Black Acid-Resisting Insulating Paint No. 27.

A black quick drying paint which is an excellent insulator and resists the action of acid and acid fumes. Has no disagreeable odor and air dries to handle in about thirty minutes. Intended as a general purpose paint for meter boards, switchboards, conduits, wiring splices, battery boxes, etc. The film is slightly plastic, and the paint gives excellent results on small D C field coils, where an air drying varnish is required.

Is supplied at a specific gravity of .865 and may be reduced with benzine to give the desired thickness of coating for the various applications.

Ajax Black Acid-Proof Paint No. 28.

A black quick-drying paint which produces a hard, glossy coating. Is thoroughly acid and water-proof. Intended especially for painting storage battery boxes. Will air dry to handle in about thirty minutes.

Is supplied at a specific gravity of .880. May be reduced with benzine or gasoline to give any desired thickness of coating. Applied by brushing or spraying.

Core Plate Varnishes

Core plate varnishes are used for insulating the sheet steel laminations of the magnetic cores of certain types of electrical apparatus to reduce the Eddy current losses. This is accomplished by applying a thin coating of varnish to the laminations before they are assembled. The oil-proof core plate varnishes are used on the laminations of oil-cooled transformers, or where a hard, tough varnish is required. The non-oil-proof varnishes are used on motors, generators, etc., where oil-proof properties are not necessary.

All core plate varnishes are supplied at a heavy consistency, and have to be reduced before use. The amount of reduction depends upon the thickness of coating desired and the method of application. The customary method of application is by means of rolls, although the varnish can also be applied by dipping or spraying. General directions for use are given on page 26.

Ajax Clear Oil-Proof Core Plate Baking Varnish No. 29.

A clear varnish which produces a tough, tenacious oil-proof coating. Intended for insulating the laminations of oil-cooled transformers. Bakes in from twenty to thirty minutes at 100°C (212°F). Will bake in less time at a higher temperature.

Is supplied at a specific gravity of .855 and should be reduced with benzine or gasoline to obtain the required thickness of coating.

Ajax Black Oil-Proof Core Plate Flashing Varnish No. 32.

A black varnish which produces a hard, tough, tenacious oil-proof coating. Intended for insulating the laminations of oil-cooled transformers, also motors, generators, etc. After application it is baked in a continuous conveyor-type oven by igniting and burning off the solvent. Bakes in from forty-five to sixty seconds at about 400°C (750°F).

Is supplied at a specific gravity of .875 and should be reduced with benzine to obtain the required thickness of coating.

Ajax Clear Air-Drying Oil-Proof Core Plate Varnish No. 30.

A clear spirit varnish which produces a smooth, oil-proof tenacious coating. Intended for insulating the laminations of oil-cooled transformers. Will air dry in ten or fifteen minutes. Apply by dipping or spraying. On account of quick drying does not work well in rolls.

Is supplied at a specific gravity of .910 and should be reduced with denatured alcohol to obtain the required thickness of coating.

Ajax Black Air-Drying Core Plate Varnish No. 31.

A black varnish which produces a smooth, tenacious coating. Intended for insulating the laminations of motors and generators. Will air dry in about twenty minutes.

Is supplied at a specific gravity of .860 and should be reduced with benzine or gasoline to obtain the required thickness of coating.

Automobile Ignition Cable Varnishes

These varnishes are intended for finishing the outer braiding of automobile ignition cable. A coating of varnish is the most effectual protection for the rubber insulation against the action of oils, gasoline, etc. The principal requirements of the varnish are elasticity and flexibility, resistance to oils, water, and high temperature.

The most satisfactory varnish for this purpose is a baking varnish, which is applied by means of baking towers. The cable is run continuously through the towers, passing first through the tank of varnish, and then vertically up and down through the baking tower where the varnish is baked. Usually two or three coats of varnish are applied. The baking time is about thirty to forty minutes at 110°C (230°F).

The methods of the various cable manufacturers vary greatly, and we make a number of varnishes for this purpose, and can supply a varnish suitable for almost every condition. The one most generally used and which we recommend is

Ajax Clear Ignition Cable Baking Varnish.

A clear varnish which produces an elastic, flexible, oil-proof finish, possessing a nice gloss.

Usually applied and baked in special baking towers. When reduced to the proper consistency the baking time is from thirty to forty minutes at 110°C (230°F).

Ajax Clear Air-Drying Cable Varnish.

We also supply an air drying varnish which can be applied by running the cable through the tank of varnish, then through a wiper to remove the excess varnish and coiling the cable on open reels to dry. The varnish will dry in twenty-four hours and two coats will produce an excellent finish on the cable.

Wire Enamels

These enamels are baking enamels intended for the insulation of copper magnet wire. We supply both clear and black enamel. The clear produces what is commonly known as Red Enameled Wire.

The enamels are applied by special machinery and as the requirements and methods of the various manufacturers differ greatly a catalog description would be of little value. We will detail one of our engineers to supply all necessary information and co-operate with a prospective user in conducting practical tests if desired.

In the development of both our Black and Red Wire Enamel we have succeeded in incorporating to a maximum degree the desirable characteristics of toughness and elasticity, resistance to the action of moisture, oils, etc., with superior flowing properties. This enables the user to produce the maximum quantity of high grade wire with the lowest percentage of waste.

Our Red Wire Enamel has been successfully used on all sizes of wire from No. 10 B & S gauge to No. 40. The Black Wire Enamel is recommended for use only on the finest sizes of wire. It combines the highest dielectric strength with the best flowing properties, but is not quite as tough as the Red Wire Enamel.

Ajax Red Wire Enamel No. 36.

For producing red enameled wire.

Ajax Black Wire Enamel No. 37.

For producing black enameled wire.

Special Reducer No. 15.

For use with Red Wire Enamel No. 36.

Special Reducer No. 75.

For use with Black Wire Enamel No. 37.

Cloth Varnishes

These varnishes are used for producing varnished cloth or cambric. We supply both clear and black varnishes and also varnishes which produce either a hard, tacky or greasy surface.

Cloth varnishes are applied by means of special baking towers and can be used only with such equipment.

The requirements of the various users vary somewhat, and a catalog description would be of little value. We will be very glad to supply complete information upon request.

In the development of our cloth varnishes we have succeeded in incorporating to a maximum degree the desirable properties of elasticity and flexibility, resistance to water and oils and the longest life under heat with excellent flowing properties.

Ajax Insulating Compounds

The solid insulating compounds are divided into two general classes—impregnating compounds and filling compounds. The former are used principally on large D C field coils, transformer coils, magnet coils, etc., and are usually applied by the vacuum pressure impregnating process. The advantages of a solid compound over a varnish for this purpose are that the compound completely fills the spaces between the conductors and produces a solid coil which facilitates the radiation of heat and more effectually excludes moisture. They are not suitable for use on armatures and rotating parts, as the combined effort of heating and centrifugal force has a tendency to soften and throw the compound out of the windings.

Filling compounds are used to fill cavities such as potheads, junction boxes, etc., principally to provide an air and water-tight seal. They are usually applied by melting and pouring into the cavity to be filled.

Ajax Oil-Proof Impregnating Compound No. 100.

A solid gum compound possessing high dielectric and mechanical strength. It is chemically inert, impervious to moisture, and unaffected by mineral oil, either hot or cold. It is very fluid when melted and yet does not sag or run out when subjected to temperatures below the melting point.

Intended for the insulation of oil-cooled transformers and coils exposed to oils.

Usually applied by vacuum pressure impregnating apparatus, but small open-type coils can be successfully treated by the open tank method. General directions for use are given on page 27.

The compound is supplied at a drip point of about 125°C (257°F) and should be reduced with Compound Reducer No. 34 to any drip point desired. Usually 100°C (212°F) gives best results.

Ajax Oil-Proof Impregnating Compound No. 109.

This is the same material as Oil-Proof Impregnating Compound No. 100, except that the reducer is added during the process of manufacture, and it is supplied at a uniform drip point of 100°C (212°F). The uses are the same as the No. 100 Compound.

Ajax Liquid Oil-Proof Impregnating Compound No. 33.

An oil-proof transformer compound in liquid form which can be applied and baked in the same manner as an insulating varnish. It is impervious to moisture and unaffected by mineral oil, either hot or cold. Especially suitable for repairing transformer coils where impregnating apparatus is not available.

The baking time and temperature will depend upon the thickness of coating and nature of coils. May be baked from six to ten hours at a temperature of from 100°C (212°F) to 135°C (275°F). Should be used as heavy as possible and reduced only with turpentine if necessary. Not recommended for use on enameled wire.

Ajax Black Impregnating Compound No. 113.

A flexible black asphaltic compound, possessing highest dielectric strength. It is chemically inert and water and acid-proof. Intended for the insulation of D C field coils, magnet coils, etc.

Usually applied by vacuum pressure impregnating apparatus, but small open-type coils can be successfully treated by the open tank method. General directions for use are given on page 27.

The compound is supplied at a drip point of about 125°C (257°F) and should be reduced with Compound Reducer No. 35 to any drip point desired. Usually about 105°C (221°F) gives best results.

Ajax Filling or Sealing Compound No. 110.

A black, asphaltic compound, which is elastic and adhesive. Is an excellent insulator and thoroughly water and acid-proof. Will withstand extremes of heat or cold without cracking. Intended for filling in sealing and insulating apparatus of various kinds, particularly automobile storage batteries.

Usually applied by melting and pouring into the cavity to be filled or sealed. Drip point approximately 100°C (212°F).

Ajax Pothead Compound No. 111.

A black asphaltic compound, which is plastic and adhesive. Is an excellent insulator and thoroughly water and acid-proof. Has a low coefficient of expansion and contraction and will withstand extremes of heat or cold without cracking. Drip

point approximately 85°C (185°F). Intended for filling pot-heads and is especially suitable for use in extremely cold climates and closed type potheads.

Should be applied by melting until it is thoroughly fluid and pouring into the pothead.

Ajax Pothead Compound No. 112.

Similar in all respects to Pothead Compound No. 111, except that the melting point is higher, 105°C (221°F). Intended for use in very hot climates and inverted type pot-heads, where the No. 111 Compound would be likely to soften and run out.

Ajax Compound Reducer No. 34.

A non-oxidizing liquid reducer for use in Ajax Oil-Proof Impregnating Compound No. 100 and No. 109, to reduce the compound to any drip point desired and also to maintain the compound at a constant drip point.

Ajax Compound Reducer No. 35.

A non-oxidizing liquid reducer intended for use in Ajax Black Impregnating Compound No. 113 to reduce the compound to any drip point desired, also to maintain the compound at a constant drip point.

General Directions for Use

The first consideration in securing satisfactory results with insulating varnishes is, of course, the selection of the proper varnish for the purpose, but of even greater importance, is using the varnish in the proper manner.

Insulating varnishes differ greatly from the other materials used in the manufacture and repair of electrical apparatus, and much greater care is required in their use. They are more or less unstable chemical compounds, and cannot be handled in the shop in the same manner as iron, steel, copper wire, mica, etc., and still give satisfactory results. A careful observance of the suggestions outlined will more than repay the user.

The first step in the use of an insulating varnish is its application to the coil or surface to which it is to be applied. This may be accomplished, either by brushing, spraying, or dipping. The second step is the drying, which is accomplished by baking in a baking oven, or by air drying, depending upon the nature of the varnish.

Baking Varnishes.

Baking varnishes are usually applied by dipping the coils or articles to be treated in a tank containing the varnish. The advantage of dipping is that the varnish more completely penetrates into the coil and thoroughly saturates the insulation. Where the size and weight of the apparatus is too great, dipping is not practical, and the varnish must be applied by spraying or brushing. Where the coils are of such a nature that all parts cannot be reached with a brush, best results will be secured by applying the varnish with an air brush. The air brush forces the varnish into all the cavities much more effectually than can be done with an ordinary brush. Large A C motors and generators, after the stator coils are assembled, can best be treated with a coating of finishing varnish, by using an air brush.

Brushing is employed principally in repair work, and to a limited extent on intermediate and large sized armatures and stators.

The recommended procedure is to first bake the coils in an oven from two to four hours at a temperature of about 100°C (212°F) to remove all moisture. The length of time will depend upon the size and nature of the coils. After baking, the coils should be dipped while still hot into the varnish and

allowed to remain until all bubbling has ceased. The coils should then be removed from the varnish and allowed to drain, after which they should be placed in the baking oven and baked until the varnish is thoroughly dried.

It is advisable when placing the coils or armatures in the baking ovens to hang them in a reverse position from that in which they were drained. This to secure a more uniform coating.

In only a few cases can satisfactory results be secured by one application of varnish. Usually the coating of varnish required is thicker than can be successfully oxidized or dried at one time, and the only alternative is to apply two or more thinner coats. Usually two coats will prove sufficient.

All conditions do not require exactly the same thickness of coating of varnish, and for this reason our varnishes are supplied heavy enough in gravity for any application, and in most cases the gravity and viscosity has to be reduced by the addition of thinner to obtain the desired thickness of film.

The first step in using the varnish is to determine just how much thinner has to be added to give the proper thickness of film, in the one, two, or three applications, as the case may be. This can only be done experimentally and after the varnish has been so reduced that correct results are obtained, the specific gravity should be taken with a hydrometer and the varnish afterwards always maintained at this specific gravity. A hydrometer measuring liquids lighter than water should be used.

As a thinner for our baking varnishes we recommend a petroleum distillate or benzine, as it is commonly called, of from 54° to 58° Baumé. Coal-tar distillates are not recommended on account of their injurious effect on enameled wire.

In thinning, both the varnish and thinner should be about the same temperature, and not less than 20°C (68°F). The thinner should be added gradually and stirred in thoroughly.

In maintaining the varnish at a uniform specific gravity, it is a good plan to also check the specific gravity or Baumé of the thinner used, as this may vary, causing a variation in the viscosity of the varnish in the tank. It should be remembered that the only object in taking the specific gravity of the varnish is to keep the thickness of coating uniform on the work. The thickness of coating is affected as much by the viscosity of the varnish, proportion and volatility of the thinner as by the specific gravity, but the latter is used on account of its convenience.

In taking the specific gravity of the varnish, allowance should be made for variations in temperature. The specific gravity of a varnish decreases as the temperature increases and vice versa. We use a standard temperature of 20°C (68°F), but any temperature may be used in computing the specific gravity of varnish in a dipping tank, if desired.

A correction factor of .0004 for each degree Fahrenheit and .0007 for each degree Centigrade should be used. For example, if at a temperature of 80°F the hydrometer reading was 0.856 the corrected specific gravity at 68°F would be 0.856, plus .0004 x 12 or 0.8608.

The following table may be used in figuring the temperature correction :

Temperature Variation °Centigrade	Specific Gravity Correction	Temperature Variation °Fahrenheit	Specific Gravity Correction	Temperature Variation °Fahrenheit	Specific Gravity Correction
1	.0007	1	.0004	13	.0052
2	.0014	2	.0008	14	.0056
3	.0021	3	.0012	15	.0060
4	.0028	4	.0016	16	.0064
5	.0035	5	.0020	17	.0068
6	.0042	6	.0024	18	.0072
7	.0049	7	.0028	19	.0076
8	.0056	8	.0032	20	.0080
9	.0063	9	.0036	21	.0084
10	.0070	10	.0040	22	.0088
11	.0077	11	.0044	23	.0092
12	.0084	12	.0048	24	.0096

Dipping Tanks.

Dipping tanks should be of such size and dimensions as to be suitable for the apparatus to be treated. They should be of such size that the temperature of the varnish will not rise excessively while the heated coils are being dipped.

For small tanks, heavy galvanized iron is a very satisfactory material. For large tanks heavy sheet steel or light boiler plate from $\frac{1}{16}$ in. to $\frac{1}{8}$ in. in thickness is the best material.

All dipping tanks should be provided with a tight-fitting cover, which should be kept closed as much as possible. This is to prevent the rapid evaporation of the solvent and to exclude air from the varnish which would tend to oxidize it and cause it to thicken up. Heavy covers should be counter-balanced.

Metal tanks should not be used for spirit varnishes. Wood tanks may be safely used.

The tanks should also have a sloping dripping pan to drain the varnish back into the tank over which the coils can be suspended, while draining. A hinged cover makes a very satisfactory arrangement for this purpose.

Large tanks which are too heavy to be handled should be provided with a faucet or other outlet to permit drawing off the varnish. This should be done regularly and the tank thoroughly cleaned. Scrupulous cleanliness is absolutely essential in the use of a varnish.

Dipping tanks should be located in a fire-proof room if possible and conveniently close to the baking oven. The temperature of this room should not be less than 20°C (68°F) and it should be well ventilated to carry off the benzine fumes.

Racks may be provided over the draining pan to hold the coils while they are draining, and for heavy work, hoists and carrying rails should be provided for handling between the dipping tank and baking oven.

Baking Ovens.

The baking oven is of great importance in securing satisfactory results with insulating varnishes. A good baking oven should have the following characteristics: Dry, uniform heat, good ventilation, good heat insulation, reliable temperature measurement, and suitable arrangements for handling the work.

Gas, electricity, and steam are most commonly used for heating and good results are obtained with each. Electricity probably gives the best results, particularly where a high gloss finish is desired. If gas is used the heat should be what is known as indirect heat, that is the products of combustion should not enter the oven. If steam is used, precautions should be taken to make sure that the steam coils are absolutely tight and that no steam enters the oven. The oven should have a temperature range of from about 85°C (185°F) to 110°C (230°F).

The heating apparatus should be so arranged that the heat will be uniformly distributed through the baking oven and that a uniform temperature will result. Care should be taken to make sure that there are no cold spots near the bottom of the oven.

The oven should be provided with flues and dampers to carry away the benzine fumes and the vitiated air. Openings

with dampers should be provided for the entrance of fresh air, and it is desirable to have the fresh air pass over the heating units as it enters the oven. This assists in maintaining a more uniform temperature throughout the oven.

Good ventilation is of the utmost importance and the flues, inlets and heater coils should be so arranged as to produce a circulation of air in the oven. In very large ovens a motor-driven blower is desirable. It should be remembered that a varnish dries by oxidation and that fresh warm air is required.

Good heat insulation is desirable as a matter of economy, but is not absolutely essential to good results, providing the oven is satisfactory in other respects.

It is important that the oven be equipped with a reliable instrument for measuring temperature. A recording thermometer or pyrometer is the most satisfactory instrument, but any good thermometer may be used. In any case, the instrument should be so located that it will give a correct indication of conditions over the oven, rather than one particular spot. To get similar conditions over the oven it will be necessary to arrange the heating units and find out by test which arrangement gives the best results.

Air Drying Varnishes.

Air drying varnishes are applied in the same manner as baking varnishes. Best results will be obtained by dipping, but the varnish may also be applied by spraying or brushing. In all cases the coils should be dry and clean and free from dust, oil, or other foreign matter.

If the varnish is applied by dipping it should first be reduced to give the proper thickness of coating as described under "Baking Varnishes." If applied by brushing usually no reduction will be found necessary.

When applying a varnish by brush, it is advisable to first apply a liberal coating, working the varnish down into the coils—then after squeezing the excess varnish from the brush, to go over the whole surface, removing the excess varnish and working the varnish down to a smooth, uniform coating.

When the varnish is used as a finishing coating on large assembled stator windings or other work where all parts cannot be reached with a brush, best results will be obtained by spraying the varnish with an air brush.

For the spirit finishing varnishes we recommend 188° denatured alcohol, and for the other air drying varnishes, petroleum, naphtha or benzine of from 54° to 62° Baumé for thinning.

The room in which the varnish is dried should be clean and warm. Under no circumstances should the temperature be less than 20°C (68°F). It should be well ventilated to carry off the benzine or alcohol fumes.

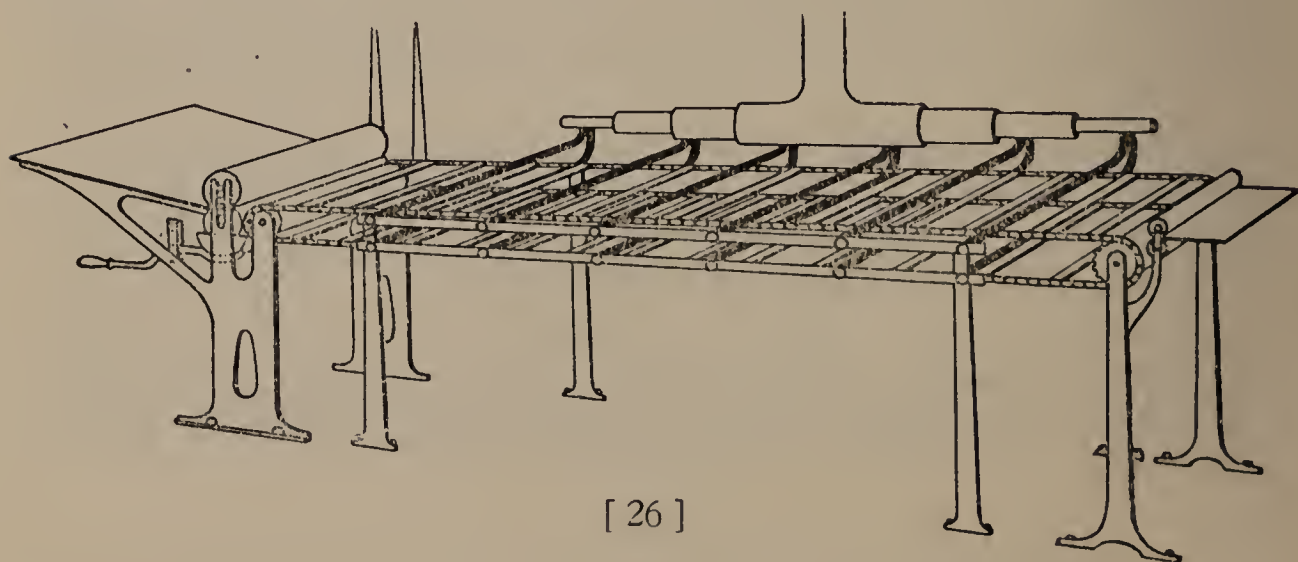
Core Plate Varnishes.

The most satisfactory method of applying core plate varnish is by means of a coating machine similar to the one illustrated on this page. The sheet steel or punched laminations are passed between two rolls, the lower of which dips into a tank of varnish. The thickness of coating is controlled by the quantity of reducer added and the pressure between the rolls. The rolls are composed of felt or printers' composition, rubber not being suitable on account of the softening effect of benzine.

After the varnish is applied it may be dried in a variety of ways. If an air drying varnish, the laminations may be hung in racks to dry or carried on a conveyor through a blast of hot air. If a baking varnish, the laminations may be hung on racks and baked in an ordinary baking oven or carried on a conveyor through a continuous baking oven. A modification of the latter plan is to ignite the solvent in the varnish as the laminations enter the oven and burn it out. This shortens the baking time very materially.

If desired the baking and flashing varnishes may be applied to the sheet steel before the laminations are punched. This greatly reduces the number of pieces handled and has the further advantage, that the varnish by holding the scale to the steel reduces somewhat the wear on the punch press dies.

If the varnish is applied to the laminations after they are punched, it is very important that all the oil used in the punching operation be removed. If a mineral oil is used the punchings can be cleaned only with benzine or gasoline. If a vegetable or animal oil is used they can be cleaned with a solution of caustic soda.



Vacuum Pressure Impregnation.

This is usually necessary only in the case of solid compounds. It is not recommended for varnishes with the exception of the plastic type, for the reason that it would not be possible to completely dry or oxidize any other kind of varnish after it had been forced into the coils.

The first step in the application of solid compounds by this process is to remove the moisture from the coils. This can best be accomplished by baking the coils in an ordinary baking oven for four hours at a temperature of about 100°C (212°F). The baking can also be done in the impregnating tank, but in this case the cover should be left open to permit the free circulation of air.

After the baking period the cover should be closed and a vacuum of at least 28 inches maintained for two or three hours. If desired the vacuum may be broken at thirty-minute intervals and immediately re-established. This assists somewhat in removing the last traces of moisture from the coils. During the vacuum period the temperature should be maintained at about 150°C (302°F).

The melted compound should then be drawn into the tank and a pressure of about 90 pounds per square inch applied and maintained from four to twelve hours, depending upon the nature of the coils and the difficulty of penetration. The melted compound should have a temperature of at least 150°C (302°F) and during the pressure period the temperature should be maintained at from 155°C (311°F) to 160°C (320°F).

At the end of the pressure period the compound should be forced back into the storage tank and it is very desirable to give the coils an after bake of three or four hours, either in the impregnating tank or in an oven. If the impregnating tank is used the cover should be opened to permit the entrance of air. The temperature should be from 125°C (257°F) to 135°C (275°F). The advantage of the after bake is that it hardens and raises the melting point of the compound and in the case of oil-proof compounds also increases the oil-proof properties.

The tank should be kept full of compound so that during the pressure period there will be only a very small air space at the top of the tank.

If liquid varnishes are applied by this process no heat should be used and after application, the varnish should be baked in the usual manner. The only purpose of impregnation would be to secure better penetration than could be obtained by dipping.

Some Common Troubles

Curdling or Separation.

This may be due to a number of causes, among which are adding thinner while the varnish or thinner is too cold, adding the thinner too rapidly and not stirring it in thoroughly, allowing the cover of the dipping tank to remain open, thus causing the varnish to partially oxidize or using a thinner which is deficient in solvent properties. It is most important that a good quality benzine be used, as many of the benzines now on the market are mixtures of light and heavy oils, and are not good solvents.

Our varnishes are very soluble in benzine and it is very seldom that trouble of this nature will be experienced with them.

Spirit varnishes sometimes thicken up when packed in tin cans after the can has been opened. This is due to a chemical reaction which takes place between the alcohol solvent and the iron of the can, most commercial tinplate being imperfectly coated with tin. Nothing can be done to correct this condition, and it is advisable to transfer the varnish from the cans to glass or earthenware containers kept for this particular purpose, if the varnish will not be used up shortly after the cans are opened.

Low Dielectric Strength.

This is due in every case to the varnish not being thoroughly hardened. The remedy for this is obvious.

Corrosion of Copper Wire.

This is due in every case to the varnish not being thoroughly oxidized. As stated before, the oil type varnishes contain vegetable drying oils and these oils are compounds of glycerin and various fatty acids. In the combined state these oils are neutral, and after they have been combined with oxygen in the process of drying they are changed into entirely different substances which have no acid character whatever. However, if a long oil varnish is applied to a coil and then not completely oxidized, the unoxidized oil will, after a time, under the action of the heat which is present in all electrical apparatus, decompose into glycerin and free fatty acids, and it is these free fatty acids which cause corrosion.

The remedy lies in the method of using the varnish. Reduce the thickness of coating or increase the baking time until the varnish is thoroughly dried. Make sure that the coils are not draining in such a manner that the varnish collects in pockets. If these measures fail to correct the trouble the only alternative is to use a shorter oil, quicker baking varnish which can be thoroughly dried in the length of time permissible.

While corrosion is due to the causes outlined it will be found that there is a wide difference in the corrosive effect of different varnishes when used under the same conditions. Varnishes which have a tendency to surface dry will form an air tight film on the surface which prevents the oxidation of the varnish underneath and such varnishes are very likely to cause corrosion.

Our varnishes are so constructed to avoid this characteristic and will oxidize in films of the maximum possible thickness.

Softening Enameled Wire.

This condition, which is sometimes noticed, is due entirely to the manner in which the varnish is used. Our varnishes contain no solvent other than benzine, which is the mildest solvent available for making varnishes. Turpentine and the coal-tar distillates are much stronger solvents and if used in an insulating varnish will attack the enamel on enameled wire. Under certain conditions a benzine solvent varnish may affect the enamel. If the coils after dipping are placed immediately in the oven and the baking started at a high temperature, the benzine is boiled off at this temperature. As is generally known, the solvent properties of any solvent are greatly increased by heating. Also the heat tends to soften the enamel and make it more readily affected by the benzine, and while at the lower temperature benzine has no effect, at the higher temperature the combined softening and solvent effect may injure the enamel. There is also a possibility that the high heat may rapidly oxidize the varnish on the surface and form a film which will prevent the escape of all the solvent underneath. The enamel would then be subjected to the action of this solvent throughout the entire baking period.

The remedy for this trouble is to allow plenty of time for draining and to start the baking at a low temperature and continue at this temperature until all the benzine has evaporated. The temperature can then be raised to the regular baking temperature. We recommend baking for the first two hours at a temperature of not over 85°C (185°F).

Comparison of Fahrenheit and Centigrade Scales.

°Cent.	°Fahr.	°Cent.	°Fahr.	°Cent.	°Fahr.	°Cent.	°Fahr.	°Cent.	°Fahr.
0..	32.0	38..	100.4	76..	168.8	114..	237.2	152..	305.6
1..	33.8	39..	102.2	77..	170.6	115..	239.0	153..	307.4
2..	35.6	40..	104.0	78..	172.4	116..	240.8	154..	309.2
3..	37.4	41..	105.8	79..	174.2	117..	242.6	155..	311.0
4..	39.2	42..	107.6	80..	176.0	118..	244.4	156..	312.8
5..	41.0	43..	109.4	81..	177.8	119..	246.2	157..	314.6
6..	42.8	44..	111.2	82..	179.6	120..	248.0	158..	316.4
7..	44.6	45..	113.0	83..	181.4	121..	249.8	159..	318.2
8..	46.4	46..	114.8	84..	183.2	122..	251.6	160..	320.0
9..	48.2	47..	116.6	85..	185.0	123..	253.4	161..	321.8
10..	50.0	48..	118.4	86..	186.8	124..	255.2	162..	323.6
11..	51.8	49..	120.2	87..	188.6	125..	257.0	163..	325.4
12..	53.6	50..	122.0	88..	190.4	126..	258.8	164..	327.2
13..	55.4	51..	123.8	89..	192.2	127..	260.6	165..	329.0
14..	57.2	52..	125.6	90..	194.0	128..	262.4	166..	330.8
15..	59.0	53..	127.4	91..	195.8	129..	264.2	167..	332.6
16..	60.8	54..	129.2	92..	197.6	130..	266.0	168..	334.4
17..	62.6	55..	131.0	93..	199.4	131..	267.8	169..	336.2
18..	64.4	56..	132.8	94..	201.2	132..	269.6	170..	338.0
19..	66.2	57..	134.6	95..	203.0	133..	271.4	171..	339.8
20..	68.0	58..	136.4	96..	204.8	134..	273.2	172..	341.6
21..	69.8	59..	138.2	97..	206.6	135..	275.0	173..	343.4
22..	71.6	60..	140.0	98..	208.4	136..	276.8	174..	345.2
23..	73.4	61..	141.8	99..	210.2	137..	278.6	175..	347.0
24..	75.2	62..	143.6	100..	212.0	138..	280.4	176..	348.8
25..	77.0	63..	145.4	101..	213.8	139..	282.2	177..	350.6
26..	78.8	64..	147.2	102..	215.6	140..	284.0	178..	352.4
27..	80.6	65..	149.0	103..	217.4	141..	285.8	179..	354.2
28..	82.4	66..	150.8	104..	219.2	142..	287.6	180..	356.0
29..	84.2	67..	152.6	105..	221.0	143..	289.4	181..	357.8
30..	86.0	68..	154.4	106..	222.8	144..	291.2	182..	359.6
31..	87.8	69..	156.2	107..	224.6	145..	293.0	183..	361.4
32..	89.6	70..	158.0	108..	226.4	146..	294.8	184..	363.2
33..	91.4	71..	159.8	109..	228.2	147..	296.6	185..	365.0
34..	93.2	72..	161.6	110..	230.0	148..	298.4	186..	366.8
35..	95.0	73..	163.4	111..	231.8	149..	300.2	187..	368.6
36..	96.8	74..	165.2	112..	233.6	150..	302.0	188..	370.4
37..	98.6	75..	167.0	113..	235.4	151..	303.8	189..	372.2

To convert degrees Centigrade into degrees Fahrenheit,
 multiply by 1.8 and add 32 or $^{\circ}\text{F} = \frac{9^{\circ}\text{C}}{5} + 32$

To convert degrees Fahrenheit into degrees Centigrade,
 subtract 32 and divide by 1.8 or $^{\circ}\text{C} = \frac{5(^{\circ}\text{F}-32)}{9}$

Comparison of Baumé and Specific Gravity Scales.

Liquids lighter than water at 15.5°C (60°F)

Degrees Baumé	Specific Gravity	Degrees Baumé	Specific Gravity	Degrees Baumé	Specific Gravity	Degrees Baumé	Specific Gravity
10.0	1.0000	28.0	0.8861	46.0	0.7955	64.0	0.7216
10.5	0.9964	28.5	0.8833	46.5	0.7932	64.5	0.7198
11.0	0.9929	29.0	0.8805	47.0	0.7910	65.0	0.7179
11.5	0.9894	29.5	0.8777	47.5	0.7887	65.5	0.7161
12.0	0.9859	30.0	0.8750	48.0	0.7865	66.0	0.7143
12.5	0.9825	30.5	0.8723	48.5	0.7843	66.5	0.7125
13.0	0.9790	31.0	0.8696	49.0	0.7821	67.0	0.7107
13.5	0.9756	31.5	0.8669	49.5	0.7799	67.5	0.7089
14.0	0.9722	32.0	0.8642	50.0	0.7778	68.0	0.7071
14.5	0.9689	32.5	0.8615	50.5	0.7756	68.5	0.7053
15.0	0.9655	33.0	0.8589	51.0	0.7735	69.0	0.7035
15.5	0.9622	33.5	0.8563	51.5	0.7713	69.5	0.7018
16.0	0.9589	34.0	0.8537	52.0	0.7692	70.0	0.7000
16.5	0.9556	34.5	0.8511	52.5	0.7671	70.5	0.6983
17.0	0.9524	35.0	0.8485	53.0	0.7650	71.0	0.6965
17.5	0.9492	35.5	0.8459	53.5	0.7629	71.5	0.6948
18.0	0.9459	36.0	0.8434	54.0	0.7609	72.0	0.6931
18.5	0.9428	36.5	0.8408	54.5	0.7588	72.5	0.6914
19.0	0.9396	37.0	0.8383	55.0	0.7568	73.0	0.6897
19.5	0.9365	37.5	0.8358	55.5	0.7547	73.5	0.6880
20.0	0.9333	38.0	0.8333	56.0	0.7527	74.0	0.6863
20.5	0.9302	38.5	0.8309	56.5	0.7507	74.5	0.6846
21.0	0.9272	39.0	0.8284	57.0	0.7487	75.0	0.6829
21.5	0.9241	39.5	0.8260	57.5	0.7467	75.5	0.6813
22.0	0.9211	40.0	0.8235	58.0	0.7447	76.0	0.6796
22.5	0.9180	40.5	0.8211	58.5	0.7427	76.5	0.6780
23.0	0.9150	41.0	0.8187	59.0	0.7407	77.0	0.6763
23.5	0.9121	41.5	0.8163	59.5	0.7388	77.5	0.6747
24.0	0.9091	42.0	0.8140	60.0	0.7368	78.0	0.6731
24.5	0.9061	42.5	0.8116	60.5	0.7349	78.5	0.6715
25.0	0.9032	43.0	0.8092	61.0	0.7330	79.0	0.6699
25.5	0.9003	43.5	0.8069	61.5	0.7311	79.5	0.6683
26.0	0.8974	44.0	0.8046	62.0	0.7292	80.0	0.6667
26.5	0.8946	44.5	0.8023	62.5	0.7273		
27.0	0.8917	45.0	0.8000	63.0	0.7254		
27.5	0.8889	45.5	0.7977	63.5	0.7235		

To convert degrees Baumé to
specific gravity.
Specific gravity = $\frac{140}{130 + ^\circ\text{B}}$

To convert specific gravity to
degrees Baumé
 $^\circ\text{Baumé} = \frac{140}{\text{Spec. Gr.}} - 130$

Steam Pressures with their Equivalent Temperature in Fahrenheit and Centigrade Scales.

Pounds Steam Pressure	Degrees Fahrenheit	Degrees Centigrade
1	216	102
5	228	109
10	240	116
15	250	121
20	259	126
25	267	131
30	274	134
35	281	138
40	287	142
45	293	145
50	298	148
55	303	151
60	308	153
65	312	156
70	316	158
75	320	160
80	324	162
85	328	164
90	332	167
95	335	168
100	337	169
105	341	171
110	344	173
115	347	175
120	350	176
125	352	178
130	356	180
135	358	181
140	361	183
145	364	184
150	366	186
160	371	188
170	375	191
175	378	192
200	388	198

Boiling Points of Water at Different Vacua

Millimetres of Mercury	Vacuum Inches of Mercury	Temperature Centigrade	Temperature Fahrenheit
756	29.74	0.0	32.
754	29.67	4.4	40.
751	29.56	10.	50.
747	29.40	15.6	60.
741	29.18	21.1	70.
734	29.89	26.7	80.
724	28.50	32.	90.
712	28.00	37.8	100.
708	27.88	8.7	101.83
657	25.85	52.3	126.15
605	23.81	60.8	141.52
553	21.78	67.2	153.01
502	19.74	72.5	162.28
450	17.70	76.8	170.06
398	15.67	80.5	176.85
346	13.63	83.7	182.86
295	11.60	86.75	188.27
243	9.56	89.5	193.22
191	7.52	91.9	197.75
139	5.49	94.3	201.96
88	3.45	96.8	205.87
36	1.42	98.5	209.55
0	0.00	100.	212.

Testing Insulating Varnishes

It is frequently necessary for the user to make tests of various insulating varnishes to determine which is most suitable for a particular purpose. This is usually done by making comparative tests of the physical, electrical, and chemical properties of the various varnishes.

The American Society for Testing Materials has recently adopted tentative specifications for testing insulating varnishes, and the reader is referred to these specifications, where it is desired to make more elaborate tests. These tests require standardized apparatus and as this is not always available the following suggestions for making comparative tests may be of value.

The most important characteristics of insulating varnishes are:

- Baking or drying time.
- Physical characteristics.
- Dielectric strength.
- Water resistance.
- Heat endurance.
- Oil resistance.
- Resistance to acids and alkalies.

As a general rule the insulation resistance and dielectric strength of all insulating varnishes is ample, the dielectric strength seldom falling below 1000 volts per mil. as determined by the usual methods. Where a measurement lower than this is observed it can usually be traced to some cause such as the varnish being under-baked or some defect in the test specimen.

It is important that in all cases the films of varnish tested be of the same thickness and each varnish baked the proper length of time for that particular varnish. The dielectric strength is increased by over-baking and a quick baking varnish baked for the same length of time as a longer baking varnish, would show a higher dielectric strength. Using the figures obtained from such a test would lead to an erroneous conclusion.

Baking or Drying Time.

This should first be determined before the further tests are begun. A good method is to dip strips of smooth copper or brass, bond paper or smooth calendered cloth in the varnish and bake in a baking oven at a uniform temperature of

100°C (212°F). The samples of varnish should first be reduced by trial so that each will give the same thickness of coating. The total thickness of film on both sides should be about .002 in. The time required for the varnish to thoroughly dry should be noted.

The varnish should be used at this consistency and baked for the length of time as determined by this test in preparing the test specimens for the various tests.

This baking time should not be confused with the baking time recommended for the varnish. A varnish which would bake in one hour under these conditions would require eight or ten hours to bake in a coil.

Physical Characteristics.

The physical characteristics such as elasticity, flexibility, hardness, toughness, plasticity, etc., can be determined by observation and will indicate the suitability of the varnish for the purpose intended.

Dielectric Strength.

Sheet copper or brass are the most satisfactory materials for preparing the test specimens. A piece about eight inches square should be used and four coats of varnish applied. Each specimen should be dipped once in each direction, withdrawn slowly from the varnish, allowed to drain and baked in the same position in which it was dipped.

The test specimen should be placed between electrodes and the testing voltage gradually raised until the varnish is punctured. Ten or more punctures should be made and the dielectric strength determined by measuring the thickness of the varnish at the points of puncture with a micrometer and computing the average dielectric strength per mil. Disc electrodes of about 1 inch diameter, with rounded edges, are best, and the testing voltage should be applied at a low figure and raised gradually. The rate of increase for all tests should be uniform.

Water Resistance.

Test specimens prepared as outlined for the dielectric strength test should be immersed in water for 24 hours. At the end of this time they should be removed, the surface water wiped off, and the dielectric strength tested immediately. The average dielectric strength after immersion when compared with the average dielectric strength of the dry specimens will indicate the effect of water on the varnish.

Heat Endurance.

Test specimens may be prepared on sheet copper or brass, as outlined for the dielectric strength test or the same test specimen may be used if desired. Strips should be cut from the sheet and placed in a baking oven the temperature of which is maintained at a uniform temperature of 100°C (212°F). A strip should be removed daily and after cooling bent around a $\frac{1}{8}$ in. rod. The number of hours the varnish withstands baking without cracking indicates the life of the varnish.

Oil Resistance.

The effect of oil can be determined by immersing the test specimens for 48 hours in transformer oil maintained at a temperature of 100°C (212°F). A quick test can be made by rubbing the test specimens with a piece of cheesecloth saturated with benzine. The test specimens prepared for the dielectric strength test after they have been punctured can be used for this test.

Resistance to Acids and Alkalies.

A simple method is to immerse test specimens in a solution of the acid or alkali and observe the effect on the varnish. The loss in dielectric strength can also be measured in the same manner as outlined for the water resistance test. In this case the period of immersion should be considerably shortened.

Packages

Ajax Insulating Varnishes and Compounds are supplied in the following standard packages :

Varnishes.

- 1-gallon cans.
- 5-gallon cans.
- 50-gallon wooden barrels.
- 55-gallon steel drums.

An invoice charge is made for the steel drums which is credited in full upon the return of the drums in good condition to our factory, freight prepaid.

Impregnating Compounds.

- 400-pound sheet iron drums.
- (No extra charge for the drums.)

Pothhead and Filling and Sealing Compounds.

- 400-pound sheet iron drums.
- (No extra charge for the drums.)

- 40-pound cans.
- 10-pound cans.
- 5-pound cans.

SHERWIN-WILLIAMS

MACHINE PAINTS AND ENAMELS

We also supply a complete line of primers, fillers, sealers, paints and enamels, suitable for finishing all classes of electrical apparatus. Color cards and catalogs describing these will be furnished upon request. The materials most generally used are:

Machine Primer.

Dark gray in color, supplied in liquid form ready for use. Is very tough and elastic, adheres perfectly and produces an ideal foundation for subsequent coats.

Machine Fillers.

Supplied in paste form in five different colors.

Machine Sealers.

Supplied in liquid form in five different colors. Suitable for sealing the filler coat.

Oil-Proof Machine Paint.

Supplied in liquid form in six different shades. The ideal material for finishing motors, generators, etc. Produces a beautiful semi-gloss or eggshell finish, which is thoroughly oil-proof.

Lustral Enamel.

Supplied in liquid form in a large variety of colors. Produces a beautiful high gloss finish which is thoroughly oil-proof. May be air dried or baked.

Black Baking Japans.

We make a line of black baking japans suitable for every requirement.

Oxydon Finishes.

A black rubber finish japan supplied in ten different grades.

Amylacetate Lacquer.

Supplied in clear, black, gloss and semi-gloss and colors.

Shellac.

Cut shellac of all types, including black shellac.

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